A STUDY OF THE PROPORTIONS OF RIGID FRAME BRIDGES

BY

NARBEY KHACHATURIAN

B.S., University of Illinois, 1947
M.S., University of Illinois, 1948

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENGINEERING
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1952

URBANA, ILLINOIS
1952

A STUDY OF THE PROPORTIONS OF RIGID FRAME BRIDGES

BY

NARBEY KHACHATURIAN

B.S., University of Illinois, 1947
M.S., University of Illinois, 1948

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENGINEERING
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1952

URBANA, ILLINOIS
1952

ACKNOWLEDGEMENTS

This thesis was written under the supervision of Thomas C. Shedd, Professor of Structural Engineering, Department of Civil Engineering, University of Illinois. The writer wishes to express his deepest thanks to him for his invaluable advice and encouragement.

Acknowledgement is also made to James R. Sims, Assistant Professor of Civil Engineering, Rice Institute, for his assistance in the preparation of Chapters I and II.

R. UNIV.
BIBLIOTHEEK
LEIDEN

A STUDY OF THE PROPORTIONS OF RIGID FRAME BRIDGES

In spite of the great progress made in the field of indeterminate structures, knowledge about them is far from complete. Indeterminate structures are still relatively complicated, and often considerable ingenuity is needed for their exact analysis and design. It is the purpose of this thesis to study a new approach to the analysis of indeterminate structures by means of which a rapid analysis can be possible. Such a method will enable the design engineer to concentrate his efforts on the proportioning of the structure without having his attention diverted by the intricacies of analysis. The structure studied in this work is the rigid frame bridge, symmetrical about the centerline of the span and with bases hinged.

In Chapter II a simple and rapid procedure is presented for the analysis of the single span rigid frame bridge with hinged bases and straight or curved deck. Achieving simplicity is the goal in this chapter; its text does not include the detailed mathematical derivations (given in an appendix) which led to the rules suggested. The chosen redundant, which is the horizontal component of reaction at the base, is presented as the product of two values namely: (i), C, a dimensionless quantity which is a function of relative proportions and material of the structure, and (ii), D, a function of the external loads and the proportion of the loaded part of the structure having the same dimension as the redundant. A study is made of the value of C and curves for its determination are presented for either a straight or curved deck. The values of D are computed for the following three conditions:

(1) The bridge subjected to a uniformly distributed load acting on the deck.

(2) The bridge subjected to a single vertical concentrated

load acting on the deck.

(3) The bridge subjected to the weight of the deck.

A general expression for the horizontal component of reaction due to a change in the length of the deck and/or horizontal displacement of the footings, is also included. It must be noted that the Principle of Virtual Work was employed for the derivation of the values of C and D. Appendix II shows briefly the mathematical derivations involved, and the simplifying assumptions.

The frames of this study are anaylzed assuming that sidesway is permitted, and the effects of earth pressures are excluded. The method presented in Chapter II can be extended to a frame in which sidesway is prevented; also the effects of earth pressures may be considered by the procedure presented in this chapter. The value of D corresponding to a typical horizontal loading can be derived, and the horizontal component of reaction at the bases can be computed. The use of this procedure is not limited to rigid frame bridges. Similar procedures can be developed for any structure the elements of which are subjected to flexural stress. In this study of rigid frame bridges it is assumed that the deck is of uniform width transversely, i.e., it is a slab structure. The cross section of the deck is assumed to be rectangular, a unit width of the bridge being considered. The method discussed in this chapter can be extended to the ribbed type of structure, either with rectangular or I-shaped beams.

In Chapter III tables and charts are presented and discussed by means of which rigid frame bridges can be analyzed very rapidly. A study is made of the relative porportions of this type of structure. By the method presented in Chapter II the variation of the ratio of moment at the center of the span to that at the corner is studied and charts are presented for the three typical conditions of loading. The proportioning of the deck is suggested on the basis of a ratio of the safety factor for flexural stress at the center to that at the corner, which may or may not be equal to one.

The data presented in Chapter III make it possible to study quickly and easily the effect of varying the relative proportions of a rigid frame bridge and to make an analysis of stresses by a simple and rapid procedure. Thus, with the help of the data presented the designer can, in a relatively short time and with a minimum of effort, study a sufficient number of designs to ensure that one finally chosen is close to the most favorable possible for the conditions that must be met.

VITA

Narbey Khachaturian was born on January 12, 1924 in Teheran, Iran (Persia). After graduating from the American Alborz High School in 1942, he entered the Polytechnic Institute of Teheran University where he completed the two year curriculum in General Engineering in June 1944.

He began his Civil Engineering study at the University of Illinois in June, 1945. He received the degree of Bachelor of Science in Civil Engineering in February, 1947, and the degree of Master of Science in June, 1948. From February, 1949 to June, 1949 he held a Teaching Graduate Assistantship in the Department of Civil Engineering, and in September, 1949 he was appointed Instructor in the same department, a position which he now holds.

He worked on the design of reinforced concrete structures and on construction of bridges at the Illinois Division of Highways in Effingham, Illinois in the fall of 1947 and the summer of 1948.

He has been a Junior Member of the American Society of Civil Engineers since February, 1947, and he was elected as an Associate Member of Sigma Xi in December, 1948.